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ABSTRACT

This study evaluated currently marketed sports bras on subjective measures of comfort and support both within an entire group of women and within cup sizes, correlated the subjective measures of comfort and support with previously reported biomechanical findings of support on the same bras, and further developed empirically based guidelines for the design of sports bras for small-, medium-, and large-breasted women. Fifty-nine subjects completed a questionnaire to assess subjective reactions to comfort and support of seven currently marketed sports bras after engaging in vigorous exercise in each bra for 20 minutes. Statistically significant differences in mean comfort and support scores among the seven styles of bras for the entire group and within cup sizes were revealed. Pearson correlation coefficients among comfort, support and displacement by bra style indicated that four of the bras performed significantly better than the remaining three, although none of the bras rated high in all three criteria. Design characteristics of the bras coming closest to this criterion (and the bras rated at least desirable) are discussed, along with recommendations for future sports bra research. A list of references and eight tables of data are appended. (Author/JD)

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Selected Sports Bras: Overall Comfort and Support

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Date: April 18, 1986

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Abstract

The purpose of this study is threefold: 1) to evaluate currently marketed sports bras on subjective measures of comfort and support both within an entire group (A, B, C and D cup sizes combined) and within cup sizes; 2) to correlate the subjective measures of comfort and support with previously reported biomechanical findings of support on the same bras (Lorentzen & Lawson, 1986), and; 3) to further develop empirically based guidelines for the design of sports bras for small, medium and large-breasted women. Fifty-nine subjects (N=14 A, 16 B, 15 C and 14 D cup sizes) were asked to complete a questionnaire to assess subjective reactions to comfort and support of seven currently marketed sports bras after engaging in vigorous exercise in each bra for 20 minutes. A two-way repeated measures ANOVA and pairwise difference procedures revealed statistically significant ($p<.05$) differences in mean comfort and support scores among the seven styles of bras for the entire group, and within cup sizes. Pearson correlation coefficients among comfort, support and displacement by bra style indicated that four fo the bras performed significantly ($p<.05$) better than the remaining three, although none of the bras rated high on all three criteria. Design characteristics of the bras coming closest to this criterion (and the bras rated at least desirable) were discussed, along with recommendations for future sports bra research.

Selected Sports Bras: Overall Comfort and Support[1]

While informal polls of active women indicate that there is a need for better designed bras for sports, few studies have attempted to approach the problem of excessive breast motion empirically. No studies have attempted to correlate empirical data on biomechanical support with subjective evaluations of comfort and support, nor have studies taken into account how bra needs may vary among women with different size breasts. This study examined subjective comfort and support evaluations of seven selected sports bras, as well as the differences on these measures within four cup size groups. In addition, subjective evaluations were compared with actual biomechanical support findings reported on identical bras in previous research.

Prior Research

Paralleling the trend toward increased numbers of non-athletes engaged in regular, strenuous exercise is the emergence of sports equipment designed especially for women. The sports bra is an example. Recommendations that female athletes ought to wear special sports bras to minimize breast injury and soreness associated with strenuous activity and to prevent sagging later in life are common in the

[1] This research was supported by a Utah State University Faculty Research Grant, from the office of the Vice President for Research, Logan, Utah. The authors wish to thank Jim Shaver for editing the manuscript and Maria Norton for consultation on the data analyses.

literature (Haycock, Shierman, & Gillette, 1978; Bayne, 1968; Haycock, 1978; Schuster, 1979; Lorentzen & Lawson, 1986).

Most studies of sports bras have examined problems and needs related to physical comfort and support. In general, comfort of a sports bra can be determined by freedom from distress that can be caused by a bra's irritating seams or parts, cutting or chafing, stiff or itchy fabric, and hot or bulky fabric. A survey of 115 U.S. college and university physical education departments and trainers of four women's football teams (Haycock et al., 1978) elicited comfort complaints about bras due to abrasive metallic or plastic parts, or to allergic reactions to the materials in the bras. All-elastic bras were found to irritate the skin, and athletes reported slipping shoulder straps and bras that "rode up." Based on research compiled from three different studies, Haycock (1978) indicated that a good sports bra should meet the following criteria related to comfort: 1) is made of a material that is absorptive, non-allergenic, non-abrasive, and most non-elastic; 2) has fasteners well covered to prevent abrasion to the skin or to other players; 3) utilizes straps that are wide, non-elastic, and designed so that they do not slip off the shoulders; 4) makes provision at the base of the bra to prevent "riding up" of the bra over the breast; and 5) provides a pocket inside the bra for placement of protective padding.

In a poll conducted by The Physician and Sportsmedicine ("Women marathoners describe their bra needs", 1977). Twenty-seven national marathon finalists also indicated the following requirements related specifically to bra comfort; an all-elastic back and availability in a wide variety of sizes. Hunter and Torgan (1982) questioned 85 inter-

collegiate athletes about the kinds of bras they used and the women stated that sports bras should be made of absorbent fabric, and constructed with seamless cups and non-irritating straps for maximum comfort.

Problems of support in a sports bra generally pertain to the nature and extent of breast motion restriction afforded by the bra, and particularly freedom from soreness and distress due to excessive breast motion. Haycock (1978) indicated that a desirable sports bra should provide good upward support and limit the motion of the breast relative to the body. Women marathoners in The Physician and Sportsmedicine poll (1977) suggested that a sports bra should provide firm support, especially from the side of the breast.

To date, three studies have used biomechanical methods (rather than informal polls or surveys) to investigate the support afforded by various bras. In a pioneer study, Haycock and associates (1978) found that breast motion was only moderately restricted by ordinary bras, but that vertical and lateral motion was markedly restricted by specially fitted bras. Because bra design may influence discomfort, Gehlsen and Albohm (1980) and Lorentzen and Lawson (1986) used biomechanical procedures to determine whether there is a difference in support provided by selected marketed sports bras. Since many of the bras examined by Gehlsen and Albohm (1980) are not currently marketed today, only the results from the more recent study by Lorentzen and Lawson (1986) will be discussed. In the latter study, the researchers compared the differences in the biomechanical support (i.e., amount of vertical displacement of the breast relative to the body allowed in A, B, C and D cup size women during jogging) provided by selected sports

bras presently on the retail market. The bras were selected on the basis of their use in previous bra research and their availability in a wide range of sizes.

Using a repeated measures ANCOVA with the mean of vertical nude breast movement in each cup size as the covariate, it was found that two of the bras had significantly lower measurements ($p < .05$) of breast vertical displacement for all cup sizes. Generally, these two bras had the following characteristics in common; both were made of very firm or barely stretchy fabric and both provided support from above and below the breasts. In addition, one incorporated a double layer of material into the cup area and the other utilized a waist-length design that produced a flattened, rounded silhouette, which served to hold the breasts close to the body. Gehlsen and Albohm's (1980) conclusion that binding over a bra prevents 45 percent of the movement is consistent with the latter finding. The two bras that performed least well were constructed of all-elastic fabric and straps, and did not provide the needed support, particularly for larger breasted women.

No research has been reported on whether the bras that minimize basic biomechanical breast movement are also given high subjective ratings on support and comfort. The data for this report came from a study in which biomechanical and subjective ratings were obtained. In addition, the present study has investigated a sample of non-athletes, rather than athletes.

Method

Objectives

The objectives of this study were threefold: 1) to evaluate currently marketed sports bras on subjective measures of comfort and support both within the group as a whole (A, B, C and D cup sizes combined) and within cup sizes; 2) to correlate the subjective measures of comfort and support with previously reported biomechanical findings of support on the same bras,(Lorentzen & Lawson, 1986) and; 3) to further develop empirically based guidelines for the design of sports bras for small, medium, and large-breasted women.

Preliminary Procedures

The subjects (Ss) were the same as in the previously reported study by Lorentzen and Lawson (1986), (N=59 total Ss; N=14, A bra cup size/small; N=16 B, and 15 C cup/medium to large; and N=14, D cup/large). All were volunteer female residents of Cache and Salt Lake Counties, Utah. The main criterion for participation was that the subject be able to complete at least 20 minutes of continuous, moderately strenuous exercises. The mean age of the entire group was 31.3 years, (range= 18-60 years). Forty-two of the Ss had no children, and the remaining 17 Ss had from one to six children. Of this group of 17 mothers, 11 (18.6% of the total sample) had breastfed their children. The mean physical characteristics of the entire group of Ss, and of each cup size group (A, B, C and D) are summarized in Lorentzen & Lawson (1986). These anthropometric data include: height, weight, percent body fat, chest and breast circumference, and chest depth and width.

Seven presently marketed sports bras were selected for field testing. They include: Elegant Support (CS), by Creative Support Systems; Jogbra (JB), by Jogbra, Inc.; Lady Duke (LD), by Royal Textile Mills; Sportsbra (CU), by Cupid; Actively Yours (AY), by Actively Yours Inc.; Olga's Christina (OC), by Olga; and Sports Bra (LF), by Lily of France. The price, and a complete description of design characteristics of each style are listed in Lorentzen & Lawson (1986).

Data Collection

Subjective rankings of the seven sports bras were obtained following actual exercise. Subjects were asked to complete a questionnaire on comfort and support for each bra after engaging in vigorous exercise for a duration of at least 20 minutes. Any activity that would produce vertical body movement and breast motion was acceptable. Subjects were asked to, and did engage in the same type, duration and intensity of exercise wearing all seven bras. The data collection process spanned a two month period, and each S tested approximately one bra per week. During the field-testing, all bras were laundered by the researchers in a uniform manner (cold water wash, line dry) to minimize possible damage to the elasticity, resiliency, and supportiveness of the bras.

Instrument

The purpose of the questionnaire was to assess subjective reactions to the comfort and support of the bras during exercise (copies of the questionnaire can be obtained from the second author). In order to construct the instrument, criteria related to comfort and support were first established from the review of the literature. In

general, questions were developed to include features found desirable or objectionable by female athletes in previous sports bra research. The questionnaire consisted of 27 separate items (questions) and was divided into three subscales: comfort (15 items), support (10 items), and overall ratings (2 items). Twenty-four items were Likert-type questions with a scaled response from one to five, and three items had a dichotomous yes/no response. For the Likert-type and dichotomous questions a one indicated the lowest amount of item comfort or support possible for a particular bra, and a five indicated the highest amount of item comfort or support possible. A total score for each subscale could be calculated by summing the single item scores. A high score on any of the subscales would indicate superior levels of comfort or support offered by the bra tested.

Validity of the questionnaire was based on self-reports of athletes about sports bra comfort and support in previous research. An estimate of internal reliability, or the extent to which single items in a subscale related to the total score of each subscale was assessed for each bra style using Cronbach Alphas. The reliability coefficients for comfort and then support for each style are as follows: CS (=.74, .66); JB (=.85, .70); LD (=.85, .15); CU (=.84, .60); AY (=.88, .62); OC (=.83, .72); and LF (=.81, .68). Reliabilities were not calculated for the third subscale since there were only two items investigated.

For each of the three subscales, the title, range of scores, and description, in that order, are presented. In Subscale One (Comfort), (15-75), 13 items relate to freedom from distress that can be caused by a bra's irritating seams or parts, cutting or chafing, stiff or itchy

fabric, and hot or bulky fabric. On the 14th item, the Ss rated the bra on overall comfort, and the 15th item the Ss indicated whether they would purchase the bra based on comfort alone.

On Subscale Two (Support), (10-50), eight of the items relate to the nature and extent of breast motion restriction provided by the sports bra and to freedom from excessive soreness and distress caused by the bra allowing excessive breast motion. The 9th item asks the Ss to rate the bra on overall support, and the 10th item assesses whether the respondent would purchase the bra, based on support alone.

On Subscale Three (Overall rating), (2-10), the first item asks Ss to give the bra an overall rating based on all considerations (both comfort and support), and the second item asks the Ss whether they would purchase the bra based on all considerations.

A pilot study utilizing 5 Ss was conducted to assess the suitability of the questionnaire and to confirm the clarity of the individual questionnaire items. Through the critiques of the inventory by the five respondents, several poorly worded questions were improved, some questions deleted, and others added.

Analysis and Results

Descriptive statistics summarizing the demographic and anthropometric data are reported in Lorentzen and Lawson (1986). To compare subjective responses to the comfort and support of the sports bras, two-way repeated measures ANOVAs were used to test differences among the mean ratings for the seven sports bras for the whole group of Ss, and also within each cup size. If a statistically significant *F* value was found, the Least Squares Difference (LSD) method was used to

identify differences between specific styles. Descriptive statistics were calculated to report the results of the two items pertaining to overall ratings, and Pearson Correlation Coefficients were calculated to report relationships between subjective comfort and support and biomechanical displacement for each bra style.

Comfort

The ANOVA yielded Statistically significant differences in mean comfort scores $F(3,54)=2.91$, $P=.043$ among the seven styles of bras for the entire group (see Table 1). Statistically significant pairwise differences for the seven styles are as follows: the comfort scores for the CU and JB bras were higher than the scores for the CS, LD and AY bras, and the LF and OC bras scored higher on comfort than the CS, LD, CU and AY bras.

Insert Table 1 about here

The statistically significant differences found within each cup size are shown in Table 2. For the A cup size all of the bras scored higher than the LD bra on comfort. Additionally, the LF, JB and OC bras scored higher on comfort than the CS bra, and the OC bra scored higher than the CU and AY bras. In the B cup size four of the bras (JB, CU, OC and LF) scored higher on comfort than the CS bra. In addition the OC and LF bras received higher comfort scores than the LD. For the C cup size, the LD, LF, OC, CU and JB bras all scored higher than the CS bra on comfort, the JB and CU scored higher than the AY, and the JB scored higher than the LD bra. Finally, for the D cup size

it was found that the OC and LF bras scored higher than the CS, LD and AY bras. In addition the JB bra scored higher than the LD, and AY bras, and the LF scored higher than the CU bra.

Insert Table 2 about here

It is apparent that four bras were consistently rated more highly on comfort than the remaining three by the entire group. In order of importance (from highest to lowest mean comfort scores) they were: the OC, LF, JB and CU bras. Generally, the same four bras were also rated as more comfortable than the remaining three bras by each cup size. It is also apparent that the LD and CS bras were consistently rated as least comfortable by the entire group and each cupsize. The latter data illustrates why the two-way interaction was not signigicant.

Support

The ANOVA yielded statistically significant differences in the mean support scores of the entire group wearing seven different styles of bras $F(3,54)=8.88$, $p=.000$. In Table 3 the statistically significant pairwise differences for support for the entire group are summarized. The CU and LD bras were rated higher on support than the CS and OC bras. In addition the LD bra rated significantly higher than the JB, CU, AY and LF bras.

Insert Table 3 about here

In Table 4 the statistically significant pairwise differences for support within each cup size group are summarized. For the A cup size there were no significant pairwise differences among the seven styles. For the B cup size the JB scored higher than the CS, AY, and LF bras. For the C cup size the LD scored higher than the AY bra style. The majority of significant pairwise differences occurred in the D cup size. The CS bra scored higher on support than the OC bra; the CU bra received higher scores than the JB, and OC bras; the AY scored higher than the JB and LF bras, and the LF scored higher than the JB. In addition the LD bra scored higher than the CS, JB, CU, and OC. It appears that support is of little importance for the A cup sizes, of only slightly greater importance for B and C cup sizes, and very important for the D cup sizes. This data illustrates the nature of the significant two-way interaction $F(18,309) = 2.93$, $P = .000$.

Insert Table 4 about here

Comparison of Biomechanical Support and Subjective Ratings of Comfort and Support

In the present study the D cup size indicated more significant pairwise differences in support among the seven bras, a finding we might expect when comparing these data with results of the previous study by Lorentzen and Lawson (1986), pertaining to biomechanical displacement of the breast in the nude condition while jogging. In this study, the D cup size scored significantly higher on displacement in the nude condition when compared to all of the remaining cup sizes.

In addition the A, B, and C cup sizes did not differ significantly from each other on this variable. Both studies indicated that support is a more important variable for the D cup size than any of the remaining three cup sizes.

The subjective ratings of support were not always consistent with the displacement data obtained on the Ss in the Lorentzen and Lawson (1986) study. This would suggest that there is more to support than simple restricition of vertical motion. For instance, the relatively low subjective support rating assigned the CS bra by the A, B, and C cup sizes (Table 4) was surprising, since the CS bra allowed less displacement than any other style (Table 5). This rating may be partially explained by the unconventionality of the design. The CS bra does not separate and uplift the breasts in the conventional manner--it compresses them close to the body. Perhaps the Ss did not perceive the style as supportive because it did not "feel" like a supportive bra usually feels. Another possible explanation for this finding is that many Ss dislike this style for reasons unrelated to support. Subjects did not like the black color, the flat silhouette, the hotness of the fabric, the waist length design, and the difficulty of putting it on and off. Because they found it uncomfortable or unacceptable in other ways, they may have been reluctant to give it high marks on support.

In general, the subjective ratings of support and the displacement data for the LD bra, which also allowed significantly less motion than all other styles except the CS bra were consistent. The LD probably owes it's high objective and subjective scores to its non-elastic fabric and straps, and to how well it separates the breasts and holds them

close to the body. It provides support from both the chest and shoulder strap area.

Insert Table 5 about here

Statistically significant Pearson Correlation Coefficients among comfort, support and displacement by bra style are illustrated in Table 6. Only the CU bra indicated significant trends among all three analyses. The JB and OC bras revealed significant trends in two of the analyses, and the LF and AY bras revealed only one significant trend each.

Comfort was significantly related to support for the JB (r =.28, p=.02), CU (r =.41, p=.00), OC (r = .40, p=.00), and LF (r = .40, p=.00) bras. However, in the case of the JB bra, plot of the variable pairs also indicates a slight curvilinear trend not noticeable by simply looking at correlation coefficients. Several Ss wearing this bra indicated increased comfort scores which correlated with decreased support scores, in addition to the reverse. This trend was not indicated with the CU, OC and LF bras.

Significant coefficients for comfort with displacement were also found for the CU (r =-.27, p=.03), and AY bras (r =-.22, p=.05); as comfort increased displacement decreased. This finding suggests that for these two bras, lower displacement values are related to higher comfort ratings.

In the final correlation analyses (support with displacement), the JB (r =-.45, p=.00), CU (r -.35, p=.00), and OC (r =-29, p=.02) bras revealed significant coefficients between the two variables. In each

case as support scores went up, displacement scores decreased. This is surprising as we would expect this finding for the most supportive bras (the CS and LD), rather than for the least supportive (OC, LF, JB, and CU) bras, (Table 5). It is apparent that selected subjective evaluations of comfort and support are correlated positively, even for those bras in which biomechanical displacement is highest.

Insert Table 6 about here

Overall Ratings

The mean response by bra style for an overall or combined comfort and support rating are shown in Table 7. The four bras rated the highest on combined comfort and support, from highest to lowest are the JB and LF ($\bar{X} = 3.47$), the OC ($\bar{X} = 3.43$), and the CU ($\bar{X} = 3.32$). The same bras (in slightly different order) were also identified as being the four bras the majority of Ss would purchase based on all considerations (refer to Table 8). These are: the OC (57.9%), the LF and JB (54.4% each), and the CU (48.3%). The findings are consistent with results from the separate comfort and support ratings with the exception of the exclusion of the LD bra, which was rated most supportive by all groups. It is interesting to note that the same four bras (with the exception of the LD) were rated highly in both the comfort and support analyses, a finding supported by the overall ratings and the correlation coefficients. This finding is not congruent with biomechanical support findings in the Lorentzen and Lawson (1986) study in which both the CS and LD bras were found to allow the least breast motion in the entire group and within each cup size. These findings suggest two things: 1)

that generally, comfort is more important than support for the majority of women (A, B, and C cup sizes) when selecting a sports bra, and 2) that Ss rating bras as more comfortable tend also to rate the same bras as more supportive than other bras, and tend to give higher overall ratings to those bras.

Insert Tables 7 and 8 about here

Discussion

The four bras which consistently rated the highest comfort across groups were the OC, LF, JB, and CU bras. The same bras also scored higher than the remaining three bras on overall ratings. The OC and JB bras are both all-elastic, have no fasteners, are constructed of a soft cotton-blend knit fabric, and have a cross-back or Y-back strap configuration that minimizes slipping of straps during exercise. These qualities were all found to be desirable in previous sports bra research. The other more conventionally styled bras which scored well on comfort, the LF and CU, are made of light, comfortable cotton-blend fabric, and incorporate stretchy areas and inserts around the cup to allow for freedom of movement.

Of the bras that did not rate well on comfort (or on the overall ratings), the CS and LD are constructed of firm, bulky, overly hot fabric, which did not allow easy expansion of the ribs in the chest area. Ss registered complaints about tightness and cutting in the armhole area, and about difficulties in getting in and out of these two bras. The latter problem is most likely due to a lack of hooks on the

part of the waist length CS bra, and to an excess of hooks (5) on the LD bra. The final bra which was not rated well on comfort, the AY, was described as having cups which were "too pointy." Subjects also complained about the rough seams on the inside of the cups, of the scratchiness of the mesh surrounding the cup, and a silhouette design fault that causes excessive pressure across the upper part of the breast but allows the lower part to sag.

Of the two bras which scored consistently low on displacement across all groups (CS and LD), only the LD was subjectively rated as being supportive. It was rated as most supportive by the entire group and each cupsize (with the exclusion of the B cup size which rated it second most supportive of all the bras). Following the CS and LD, the JB bra scored lowest on displacement. In addition it was rated highly on comfort and support across groups, and scored well on the overall ratings.

The results of this study and of the biomechanical study on the same bras (Lorentzen & Lawson, 1986) indicate that there is no clear winner among the seven styles of sports bras. None of the bras rated highly on all criteria: control of vertical displacement, comfort ratings, support ratings, and overall ratings. Four bras (JB, CU, OC and LF) came closest to this criterion. In general, these bras scored highly on comfort and overall ratings, and indicated more significant correlations among comfort, support and displacement. Of this group two of the styles that were highly rated on comfort (CU, OC) tended to have higher displacement scores. The other two bras in this group (the JB and LF) also rated highly on comfort, but only moderately high on displacement. The latter two bras seem to have reached a compromise

between comfort and displacement, but may not have rated particularly well on either criterion. These results pose a difficult dilemna for the sports bra designer.

Recommendations for Sports Bra Design

1. Cup size styles should not all be designed exactly the same. For larger breasted women (D cup size and up), control of displacement is essential for pain-free exercise, while for smaller and medium breasted women (A, B, and C cup sizes) this variable is not as important. Larger cup size designs should incorporate non-stretch cup fabrics and straps, and a design that provides support from all sides of the breast. Designs for smaller breasted women should utilize design features that are geared more toward comfort.

2. A follow-up survey of participants in this study indicates that many larger breasted women would prefer a sports bra design that incorporates an underwire, since they feel that the underwire provides better separation and support. Underwires should be developed that are flat, flexible and non-irritating (don't "cut in" under the breast). An underwire design incorporating other features desirable in a sports bra would meet the needs of many large breasted women better than existing styles of sports bras. None of the designs in the present study had underwires.

3. Sports bra manufacturers need to re-evaluate the silhouettes of their sports bras and make design changes that will lessen breast motion while increasing appeal, especially for large breasted women. Ideally, a sports bra will provide some separation between the breasts,

but at the same time, the contour should be as non-pointed as possible so that the breasts are held closer to the body.

4. Manufacturers need to reconsider strap design and configurations, and how they relate to the neckline and armhole designs of other athletic apparel such as leotards and running singlets. More effort could be applied to coordinating strap position with necklines so that neither functionality or attractive appearance is lost.

Recommendations for Further Research

1. There is a need to develop more objective means of assessing comfort and support. This could be partially accomplished through the use of pressure point analysis and the utilization of heat and temperature sensors to measure how effectively heat and moisture are allowed to leave the breast during exercise.

2. Since all clothing creates a microenviroment around the body, there is a need for more research on how clothing affects the body's thermo-regulatory capacities, and for the development of fibers and fabrics that enhance the body's capabilities to accomplish thermo-regulation during exercise. It may be valuable to identify design characteristics important in a sports bra by sport (i.e. sports that require more arm movement than others, and/or sports performed outdoors in cold weather versus those performed indoors or in hot weather).

3. Sports bra research efforts should concentrate on the needs of larger breasted women in an effort to remove barriers to exercise that may presently exist for these women. Specifically, it is suggested that future research utilize only D cup or above Ss.

4. The psychological needs of women of all sizes and ages, relating to sports bra usage, should be assessed (i.e. perceptions of how women feel they are perceived in certain silhouettes) for design use in order to break down barriers with may inhibit healthy exercise habits and enjoyment (Lorentzen & Lawson, 1986; Haycock, 1978).

5. For researchers wishing to investigate subjective evaluations of comfort and support of sports bras, we suggest field-testing each style for a period of one or two weeks (rather than a single test). In addition to gathering structural questionnaire data, post field-testing interviews would provide more complete and comprehensive information on women's needs and satisfaction with available breast support. In this instance, it would also be important to randomize the order in which the bra styles are worn.

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TABLE 1

ANOVA Summary Table and Analysis of Pairwise Differences (LSD method) for Comfort Scores for the Combined A, B, C, and D Cup Sizes Wearing Seven Styles**

Source of Variation	df	MS	F	p Level	Eta^2
Main Effect					
Cupsize (S)	3	396.45	2.91	0.043	.04
Person/Cupsize (P)					
[Error A]	54	135.57	2.69	0.000	.23
Style of Bra (B)	6	772.49	15.33	0.000	.01
Cupsize x Style	18	76.51	1.51	0.080	.05
Style x Person/ Cupsize [Error B]	298	50.36			
Total	379	1,431.38			

Pairwise Differences*

Mean	S.D.	Style	CS	JB	LD	CU	AY	OC	LF
Seven Styles									
58.81	.984	CS							
59.24	.962	LD							
61.27	.973	AY							
64.55	.969	CU	*		*		*		
66.83	.993	JB	*		*		*		
67.43	1.010	LF	*		*	*	*		
67.44	.967	OC	*		*	*	*		

*Denotes pairs of groups significantly different, $p<.05$. In each pairwise case, the style in the horizontal row scored significantly higher on overall comfort than the style in the column.

**$R^2 = .49$

TABLE 2

Analysis of Pairwise Differences for Comfort Scores For Each Cup Size in the Seven Styles (LSD Method)

Mean	S.D.	Style	CS	JB	LD	CU	AY	OC	LF
A Cup									
52.93	1.90	LD							
59.50	1.90	CS			*				
62.36	1.90	AY			*				
62.71	1.90	CU			*				
65.80	1.98	LF	*		*				
66.30	1.98	JB	*		*				
68.88	2.08	OC	*		*	*	*		
B Cup									
57.88	1.77	CS							
61.38	1.77	LD							
61.77	1.84	AY							
65.48	1.84	JB	*						
65.63	1.77	CU	*						
67.19	1.77	OC	*		*				
67.22	1.84	LF	*		*				
C Cup									
58.67	1.99	CS							
63.93	1.83	AY							
64.73	1.83	LD	*						
68.34	1.91	LF	*						
68.62	1.91	OC	*						
69.73	1.99	CU	*				*		
70.54	1.90	JB	*		*		*		
D Cup									
57.02	2.19	AY							
59.93	2.17	LD							
59.20	2.18	CS							
60.13	2.08	CU							
64.93	2.19	JB			*		*		
65.07	1.97	OC	*		*		*		
68.38	2.31	LF	*		*	*	*		

*Denotes pairs of groups significantly different, $p<.05$. In each pairwise case, the style in the horizontal row scored significantly higher on comfort than the style of the column.

TABLE 3

ANOVA Summary Table and Analysis of Pairwise Differences (LSD Method) for Support Scores for the Combined A, B, C, and D Cup Sizes Wearing Seven Styles**

Source of Variation	df	MS	F	p Level	Eta^2
Main Effect					
Cupsize (S)	3	573.28	8.88	0.000	.11
Person/Cupsize (P)					
[Error A]	54	64.33	2.37	0.000	.22
Style of Bra (B)	6	121.24	4.46	0.000	.05
Cupsize x Style	18	79.58	2.93	0.000	.09
Style x Person/ Cupsize					
[Error B]	309	27.18			
TOTAL	390	865.61			

Pairwise Differences*

Mean	S.D.	Style	CS	JB	LD	CU	AY	OC	LF
35.47	.702	OC							
35.74	.713	AY							
36.00	.702	CS							
36.56	.687	JB							
36.92	.725	LF							
37.52	.700	CU	*					*	
39.85	.707	LD	*	*		*	*	*	*

*Denotes pairs of groups significantly different, $p<.05$. In each pairwise case, the style in the horizontal row scored significantly higher on support than the style in the column.

**R^2 = .47

TABLE 4

Analysis of Pairwise Differences for Support Scores for Each Cupsize in the Seven Bra Styles (LSD Method)

Mean	S.D.	Style	CS	JB	LD	CU	AY	OC	LF
A Cup									
36.66	1.52	AY							
37.50	1.39	JB							
38.20	1.39	CS							
38.50	1.39	LF							
39.29	1.39	OC							
39.43	1.39	CU							
40.71	1.39	LD							
B Cup									
35.75	1.30	AY							
36.66	1.35	CS							
36.86	1.54	LF							
38.06	1.35	OC							
38.25	1.30	CU							
40.00	1.30	LD							
41.31	1.30	JB	*				*		*
C Cup									
35.47	1.35	CS							
35.53	1.35	AY							
35.80	1.35	LF							
36.67	1.35	CU							
37.20	1.35	OC							
39.20	1.35	JB							
39.33	1.35	LD	*				*		
D Cup									
27.34	1.52	OC							
28.23	1.45	JB							
33.59	1.52	CS						*	
34.72	1.51	CU		*				*	
35.01	1.52	AY		*					*
36.51	1.52	LF		*					
37.34	1.59	LD	*	*		*		*	

*Denotes pairs of groups significantly different, $p<.05$. Note: In each pairwise case, the style in the horizontal row scored significantly higer on support than the style in the column.

TABLE 5

Analysis of Pairwise Differences for Vertical Displacement Within Cup Sizes by Style

Mean (cm)	S.D.	Style	CS	JB	LD	CU	AY	OC	LF
A Cup									
1.34	.31	LD				*	*		*
1.70	.31	CS				*			*
2.14	.31	AY							
2.19	.31	JB							
2.33	.31	OC							
2.63	.31	LF							
2.96	.31	CU							
B Cup									
1.38	.29	CS		*		*	*	*	*
1.93	.29	LD				*	*	*	
2.41	.29	JB							
2.46	.29	LF							
2.77	.29	AY							
2.77	.29	OC							
2.89	.29	CU							
C Cup									
1.53	.30	CS		*		*	*	*	*
1.87	.30	LD		*		*	*	*	*
2.99	.30	JB							
3.07	.30	CU							
3.35	.30	AY							
3.47	.30	LF					*	*	*
3.51	.30	OC							
D Cup									
2.08	.31	CS		*	*	*	*	*	*
2.85	.31	LD		*		*	*	*	*
3.64	.31	LF		*				*	
4.16	.31	AY							
4.27	.31	CU							
4.49	.31	JB							
4.62	.31	OC							

*Denotes pairs of groups significantly different, $p<.05$. Note: In each pairwise case, the style in the horizontal row scored significantly lower on displacement than the style in the column.

TABLE 6

Pearson Correlation Coefficients and Significance Levels Between Comfort, Support and Displacement by Bra Styles*

Correlation Coefficients & Probabilities	Bra Styles						
	CS	JB	LD	CU	AY	OC	LF
Comfort with Support		.28 p=.02		.41 p=.00		.44 p=.00	.40 p=.00
Comfort with Displacement				-.27 p=.03	-.22 p=.05		
Support with Displacement		-.45 p=.00		-.35 p=.00		-.29 p=.02	

*Only those correlations with $p<.05$ are reported.

TABLE 7

Means and Standard Deviations of Overall Comfort and Support Responses by Bra Styles

	Bra Styles						
	CS	JB	LD	CU	AY	OC	LF
Mean Response*	2.78	3.47	2.91	3.32	2.81	3.43	3.47
Standard Deviation	.96	1.16	1.11	1.11	1.19	1.23	1.11
Sample Size	58	57	57	58	58	57	57

*Scores ranged from 1 (least desirable) to 5 (most desirable)

TABLE 8

Percentage of Subjects Indicating They Would Purchase a Bra Based on all Considerations, by Bra Styles

	Bra Styles						
	CS	JB	LD	CU	AY	OC	LF
%	24.1	54.4	31.6	48.3	37.9	57.9	54.4